Activities of Japanese Steel Industry to Combat Global Warming
Report of “JISF’s Commitment to a Low Carbon Society”

February 2020
The Japan Iron and Steel Federation
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Japanese steel industry is supporting the Commitment to a Low Carbon Society by fighting global warming with the “three ecos” created during the Voluntary Action Plan along with COURSE50.

Eco Process
The target is a CO$_2$ emission reduction of 5 million tons by FY2020 vs. expected emissions for each production volume (BAU) by fully implementing state-of-the-art technologies. Of this reduction, JISF prioritizes 3 million tons of reduction arising from energy conservation and other voluntary actions by steelmakers. For waste plastics and other recycled materials, the emission reduction includes only a decrease resulting from the increase in the volume of these materials collected vs. the FY2005 level.

Eco Solution
Contribute worldwide by transferring the world’s most advanced energy-saving technologies to other countries (especially to developing countries) and increasing the use of these technologies. (Estimated emission reduction contribution of about 70 million tons in FY2020)

Eco Product
By supplying the high-performance steel that is essential to create a low-carbon society, contribute to lowering emissions when finished products using this steel are used (Estimated emission reduction contribution of about 34 million tons in FY2020)

Development of CO2 Ultimate Reduction System for Cool Earth 50 (COURSE50)
Cut CO$_2$ emissions from production processes about 30% by using hydrogen for iron ore reduction and collecting CO$_2$ from blast furnace gas. The first production unit is to begin operations by about 2030*. Goal is widespread use of these processes by about 2050 in line with timing of updates of existing blast furnace facilities.

* Assumes establishment of economic basis for CO$_2$ storage infrastructure and creation of a practical unit using these processes.
1. Eco Process
On February 20, 2014, JISF became the first industry association in the world to receive ISO50001 certification (energy management system). This certification recognizes measures to combat global warming in the Voluntary Action Plan/Commitment to a Low Carbon Society as well as activities for conserving energy.
Reexamination of Stance for Targets Established in FY2016

Eco Process **Before reexamination**

The target is a CO2 emission reduction of 5 million tons by FY2020 vs. expected emissions for each production volume (BAU) by fully implementing state-of-the-art technologies.

Eco Process **After reexamination**

The target is a CO2 emission reduction of 5 million tons by FY2020 vs. expected emissions for each production volume (BAU) by fully implementing state-of-the-art technologies. Of this reduction, JISF prioritizes 3 million tons of reduction arising from energy conservation and other voluntary actions by steelmakers. For waste plastics and other recycled materials, the emission reduction includes only a decrease resulting from the increase in the volume of these materials collected vs. the FY2005 level.

Interim- Review

1. Properly determine BAU by reflecting changes in steel production mix
2. Include actual emission reductions resulting from the use of waste plastics and other recycled materials
Calculation of BAU Emissions for FY2018 Performance Evaluation

(1) Calculation of BAU Emission prior to adjustment

Calculated using the regression equation* and crude steel output

BAU regression equation: \( y = 1.271x + 0.511 \) (\( x = \) Crude steel output)

* The correlation function for crude steel output and \( \text{CO}_2 \) emissions was established based on the regression equation obtained by analyzing the correlation between crude steel output and \( \text{CO}_2 \) emission intensity for FY2005-FY2009 (using the FY2005 electricity coefficient every year).

FY2018 crude steel output (total for participating companies) = 98.97 million tons

Adjustment FY2018 BAU emissions = 176.85 million tons of \( \text{CO}_2 \) (A)

(2) Calculation of change in \( \text{CO}_2 \) emissions due to change in production mix

\( \text{CO}_2 \) conversion using changes in upstream (pig iron ratio) and downstream (product category mix) processes based on the RITE index

Upstream change volume: +0.30mn tons of \( \text{CO}_2 \)  
Downstream change volume: -0.73mn tons of \( \text{CO}_2 \)

FY2018 change in \( \text{CO}_2 \) due to change in production mix (upstream and downstream): -430,000 tons of \( \text{CO}_2 \) (B)

(3) Adjusted BAU Emissions

FY2018 adjusted BAU Emissions = 176.42 million tons of \( \text{CO}_2 \) [(A) + (B)]
Reexamination of BAU by reflecting changes in steel production mix (1)

- Up to FY2014, the JISF’s Commitment to a Low Carbon Society used evaluations with a BAU line (left graph) incorporating the assumption that the FY2005 production mix will not change.
- Currently, changes are taking place in the production mix. For example, as Japanese steelmakers move production to Southeast Asia and other overseas locations, the shift of some final production processes has raised the percentage of intermediate products (such as hot-rolled sheets). Also, the percentages of some finished products (such as galvanized sheets) are decreasing. Pig iron production has increased in proportion to these changes and CO₂ emissions are rising as a result.
- Incorporating these changes was not possible with the previous BAU line. Consequently, the change in CO₂ associated with the production mix change was calculated by using the production mix index produced by RITE (the RITE index). Starting in FY2015, emissions have been evaluated by using the adjusted BAU line, which incorporates the BAU line.

* This target assumes that Japan’s crude steel output will be 120 million tons, with a variance of no more than 10 million tons.
* The colored sections of the graphs on this page show the range of production at companies participating in the Commitment to a Low Carbon Society when Japan’s crude steel output is between 110 million and 130 million tons.
(Reference) Changes in steel production mix

- When determining the RITE index, the total change in CO₂ emissions caused by a production mix change is evaluated by adding the changes in emissions associated with a change in the pig iron ratio for upstream processes and a change in the product mix for downstream processes.
- The BAU line uses a production mix that remains the same as in FY2005. As a result, it is possible to perform a proper evaluation with the BAU line in which the changes in the production mix are incorporated by shifting the line according to the changes.

Share of Pig Iron (Upstream processes)

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2017</th>
<th>2018</th>
<th>18-05 (%)</th>
<th>18/05 (%)</th>
<th>18-17 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude steel (1000t)</td>
<td>112,718</td>
<td>104,837</td>
<td>102,886</td>
<td>-9.832</td>
<td>-8.7</td>
<td>-1.951</td>
</tr>
<tr>
<td>EAF(1000t)</td>
<td>28,595</td>
<td>25,201</td>
<td>25,655</td>
<td>-2.940</td>
<td>-10.3</td>
<td>454</td>
</tr>
<tr>
<td>Pig Iron (1000t)</td>
<td>82,937</td>
<td>78,365</td>
<td>75,920</td>
<td>-7.017</td>
<td>-8.5</td>
<td>-2.446</td>
</tr>
<tr>
<td>BF-BOF (%)</td>
<td>74.2</td>
<td>75.6</td>
<td>74.7</td>
<td>0.5</td>
<td>-0.9</td>
<td>-</td>
</tr>
<tr>
<td>EAF (%)</td>
<td>25.4</td>
<td>24.0</td>
<td>24.9</td>
<td>-0.4</td>
<td>-0.9</td>
<td>-</td>
</tr>
<tr>
<td>Pig Iron (%)</td>
<td>73.6</td>
<td>74.7</td>
<td>73.8</td>
<td>0.2</td>
<td>-1.0</td>
<td>-</td>
</tr>
</tbody>
</table>

- An increase of 0.2 percentage point in pig iron’s share from FY2005 to FY2018

Share of Long and Flat Products (Downstream processes)

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2017</th>
<th>2018</th>
<th>18-05 (%)</th>
<th>18-17 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td>7.5</td>
<td>6.8</td>
<td>6.9</td>
<td>-0.6</td>
<td>0.2</td>
</tr>
<tr>
<td>Bar</td>
<td>12.3</td>
<td>9.9</td>
<td>10.3</td>
<td>-2.0</td>
<td>0.3</td>
</tr>
<tr>
<td>total</td>
<td>23.5</td>
<td>20.0</td>
<td>20.4</td>
<td>-3.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Flat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plate</td>
<td>11.3</td>
<td>9.7</td>
<td>10.9</td>
<td>-0.4</td>
<td>1.2</td>
</tr>
<tr>
<td>HRS</td>
<td>11.3</td>
<td>18.4</td>
<td>16.7</td>
<td>5.3</td>
<td>-1.7</td>
</tr>
<tr>
<td>Cold-rolled flat products</td>
<td>8.6</td>
<td>7.9</td>
<td>8.0</td>
<td>-0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Galvanized sheet</td>
<td>14.6</td>
<td>12.7</td>
<td>12.7</td>
<td>-2.0</td>
<td>0.0</td>
</tr>
<tr>
<td>total</td>
<td>46.3</td>
<td>49.1</td>
<td>48.7</td>
<td>2.3</td>
<td>-0.4</td>
</tr>
</tbody>
</table>

- In flat products, HRS (hot-rolled strips) increased and cold-rolled flat products and galvanized sheets decreased.

CO₂ conversions using the RITE index to incorporate the above changes

- Upstream: +296 mmtCO₂
- Downstream: -732 mmtCO₂
- Total: -436 mmtCO₂
Crude steel is made by reducing natural resources to make pig iron or by using steel scrap that has already been reduced. The pig iron ratio is the amount of pig iron produced in relation to the production of crude steel (pig iron output divided by crude steel output). Variations in this ratio also affect unit CO₂ emissions.

To evaluate this effect properly, a primary coefficient is established that includes (1) comprehensive energy statistics, (2) IEA energy balance table, (3) environmental reports of steelmakers, (4) international peer-reviewed papers and other items.

The number obtained by using this primary coefficient is the upstream process index. The formula is: \( y \) (Upstream index) = 1.419 \( x \) (Pig iron ratio) + 0.70.

Changes in CO₂ emissions caused by changes in the pig iron ratio are calculated multiplying the difference between the upstream process index for FY2005 and each subsequent year by crude steel output.

### Actual data (FY2005 and FY2017)

<table>
<thead>
<tr>
<th>Year</th>
<th>Pig iron ratio</th>
<th>Upstream process index</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2005</td>
<td>0.736</td>
<td>1.743</td>
</tr>
<tr>
<td>FY2018</td>
<td>0.738</td>
<td>1.746</td>
</tr>
</tbody>
</table>

\[ \text{FY2005: } 1.419 \times 0.736 + 0.70 = 1.743 \]
\[ \text{FY2018: } 1.419 \times 0.738 + 0.70 = 1.746 \]

Change in CO₂ emissions due to change in pig iron ratio (FY2018)

\[ (1.746-1.743) \times 98,97 \text{ mnt} = 30 \text{ mnt} \]

⇒ Assessed as a 30 million ton increase in CO₂ emissions.
**Summary of the Downstream Process Index**

Unit CO₂ emissions per ton of production* have been established for different shapes of ordinary steel and types of specialty steel, a total of 35 product categories, for which general statistics are accessible. Using FY2005 as the reference year, the change in CO₂ emissions caused by the change in the production mix in each year is then calculated. This calculation is performed as follows. Meanwhile, up until the previous fiscal year’s report, the total amount was calculated by multiplying the above-mentioned difference between the unit emission figure for fiscal 2005 and the same figure for the year under review by the amount of production of crude steel. However, changes in the downstream processes are changes in the mix of steel product categories. **Therefore, starting from this report, the amount computed by multiplying the amount of production of crude steel by the yield ratio of steel products to crude steel for fiscal 2005 (this is equivalent to the amount of production of steel products) is used to calculate the total amount.**

A. The product mix ratio for each steel product in each year (Table 1) and unit CO₂ emissions (Table 2) are multiplied (Table 3).

B. All the numbers obtained from the step A are added (which yields a composite unit emission value weighted for the production mix): 0.846 in FY2005 and 0.838 in FY2018 in the table below.

C. The total amount is calculated by multiplying the difference between the composite unit emission figure for the year under review and the same figure for the base year (fiscal 2005), which is obtained in step B, by the amount for the year under review that is computed by multiplying the amount of production of crude steel by the yield ratio of steel products to crude steel for fiscal 2005 (this is equivalent to the amount of production of steel products).

For FY2018: \((0.838-0.846) \times 98.97\text{mnt} \times 0.907 = -0.73\text{mnt}\)

*Unit CO₂ emissions for each steel product category for all years are based on the worldsteel LCI data collection. Averages for Japan calculated by using actual FY2014 data are used when available for these products. For products where there is no Japan average, unit emissions are estimated by using the relationship between unit emissions for steel for which Japan averages exist and selling prices (FY2010 export prices using trade statistics).

### Table 1: Product mix ratio (1)

<table>
<thead>
<tr>
<th>Steel bars</th>
<th>Hot-rolled strips</th>
<th>Cold-rolled sheets</th>
<th>Galvanized sheets</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2005</td>
<td>12.3%</td>
<td>9.9%</td>
<td>6.6%</td>
<td>12.0%</td>
</tr>
<tr>
<td>FY2018</td>
<td>10.3%</td>
<td>14.5%</td>
<td>6.5%</td>
<td>10.1%</td>
</tr>
</tbody>
</table>

### Table 2: Unit CO₂ emissions per ton of production (2) (common figures)

<table>
<thead>
<tr>
<th>FY2005</th>
<th>0.09</th>
<th>0.07</th>
<th>0.05</th>
<th>0.11</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2018</td>
<td>0.07</td>
<td>0.10</td>
<td>0.05</td>
<td>0.1</td>
</tr>
</tbody>
</table>

\[(3) = (1) \times (2)\]

| FY2005 | 0.846 |
| FY2018 | 0.838 |

A composite unit emission figure that reflects the product mix in each year.
FY2018 Results of JISF’s Commitment to a Low Carbon Society

Progress toward targets *Totals for companies participating in the Commitment to a Low Carbon Society

- Crude steel production: 98.97 million tons (down 8.4% from FY05)
- BAU emissions for FY18 crude steel production: 176.42 million tons of CO$_2$ - (1)
- CO$_2$ emissions (using FY05 electricity coefficient): 174.20 million tons (down 7.5% from FY05) - (2) ※1
- Reduction vs. BAU: 2.21 million tons of CO$_2$ (0.79 million tons above the target) ※2

※1. Unit calorific values and carbon emission factors in the Comprehensive Energy Statistics were used to calculate the fiscal 2018 amount. In fiscal 2019, unit calorific values and carbon emission factors in the Comprehensive Energy Statistics were revised, and JISF provided relevant data for coking coal, PCI coal, coal coke, coke-oven gas, and converter gas. Therefore, revised factors were used for these.

※2. The amount of waste plastic and other recycled materials used declined from fiscal 2005, which pushed up CO$_2$ emissions (by 140,000 tons). But this increase is not included.

Reference: Japanese steel industry total
(including not participating companies participating in the Commitment to a Low Carbon Society)

- Crude steel production: 102.89 million tons (down 8.7% from FY05)
- Energy consumption: 2,197PJ (down 6.9% from FY05)
- CO$_2$ emissions (using electricity coefficient with FY18 credit): 181.57 million tons (down 5.8% and 11.09 million tons of CO$_2$ from FY05)

* Energy consumption and CO$_2$ emissions for the Japanese steel industry are estimates based on statistics for the use of petroleum and other energy sources.
Unit calorific values and carbon emission factors in the Comprehensive Energy Statistics were used to calculate the fiscal 2018 amount. In fiscal 2019, unit calorific values and carbon emission factors in the Comprehensive Energy Statistics were revised, and JISF provided relevant data for coking coal, PCI coal, coal coke, coke-oven gas, and converter gas. Therefore, revised factors were used for these calculations.
In FY2018, CO₂ emissions were 2.21 million tons below the BAU level. Energy and CO₂ conservation measures cut emissions by 2.73 million tons, aging bricks in coke ovens raised emissions by 1.01 million tons, and other measures cut emissions by 0.50 million tons. These figures do not include changes in CO₂ emissions caused by the use of waste plastic. 0.79 million tons below the target.
## Evaluation of FY2018 Performance

### 1. Progress with measures incorporated in the target

<table>
<thead>
<tr>
<th>Expected target</th>
<th>FY 2017</th>
<th>FY 2018</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| (1) Reductions from energy saving actions | -3.00Mt | -2.78Mt | -2.73Mt | • Progress of about 90% toward the target between FY05-FY18 (13 years)  
*Starting this fiscal year, the CO₂ reduction effects of projects for which energy conservation subsidies are granted (projects that contribute to improving unit fuel consumption, including the use of regenerative burners) in relation to “more energy conservation” are quantified, and these were applied retroactively for the past years as initially assumed measures.  
- The amount of reduction was lower than in the previous fiscal year. This is probably because the reduction effects of operational efforts were diminished by temporary troubles, etc. |

### 2. Factors affecting emissions that were unforeseen when targets were established

<table>
<thead>
<tr>
<th>Expected target</th>
<th>FY 2017</th>
<th>FY 2018</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| Aging coke oven bricks | — | +1.11Mt | +.24Mt | • Aging coke oven bricks caused unit energy consumption to climb. Probable causes are the aging of bricks and the impact of the Tohoku earthquake and tsunami of 2011  
• JISF member companies have successively started renewing coke ovens, and as a result, the increase in the amount of CO₂ emissions declined in fiscal 2018. However, the level of increase of CO₂ emissions is still high at 1.01 million tons, and these effects have not been abolished. |
| Other issues | — | -1.04Mt | -1.08Mt | • It is difficult to pinpoint the causes of this decline. But it seems that energy conservation factors, such as operational efforts, surpassed energy waste factors.  
• The amount of reduction was lower than in the previous fiscal year. This is probably because the reduction effects of operational efforts were diminished by temporary troubles, etc. |
| Total | — | +0.28Mt | +0.52Mt | |

### 3. Progress toward targets (1+2)

<table>
<thead>
<tr>
<th>Expected target</th>
<th>FY 2017</th>
<th>FY 2018</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction vs. BAU</td>
<td>-3.00Mt</td>
<td>2.49Mt※</td>
<td>-2.21Mt</td>
</tr>
</tbody>
</table>

### 4. Progress with using waste plastics

<table>
<thead>
<tr>
<th>Expected target</th>
<th>FY 2017</th>
<th>FY 2018</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher waste plastic use</td>
<td>—</td>
<td>▲7</td>
<td>+14</td>
</tr>
</tbody>
</table>

*The previous fiscal year’s report said that the amount of CO₂ emissions in fiscal 2017 was 2.29 million tons lower than the BAU level, and the BAU adjustment due to changes in steel production mix was plus 180,000 tons (plus 1.68 million tons for the upstream processes and minus 1.50 million tons for the downstream processes). As stated in page 10, starting this fiscal year, the calculation method incorporating the yield ratio of steel products to crude steel is adopted for the downstream processes and this was applied retroactively for the past years. Therefore, the BAU adjustment for the downstream processes for fiscal 2017 was minus 1.29 million tons, and the overall BAU adjustment was plus 390,000 tons. As a result, the amount of CO₂ emissions in fiscal 2017 was 2.49 million tons lower than the BAU level.
JISF member companies have started replacing aging bricks in coke ovens, which is one cause of the increase in CO2 emissions. Improvements at 11 coke ovens were already completed during Phase I of the Commitment to a Low Carbon Society.

Although work has started, it will be impossible to solve all the issue of increasing CO2 emissions in 2020 because of the limited availability of workers (coke oven construction specialists) and the high cost of updates (tens of billions of yen for each oven).

### Coke Oven Updates

#### 1. Eco Process

**JISF Member Company Coke Oven Update Plans** (Company and newspaper announcements as of February 2020)

**1. Completed Updating Projects (11 ovens)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Steel works</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2013</td>
<td>JFE Steel, West Japan Works, Kurashiki</td>
<td>About ¥15 billion</td>
</tr>
<tr>
<td>FY2015</td>
<td>JFE Steel, West Japan Works, Kurashiki</td>
<td>About ¥20 billion</td>
</tr>
<tr>
<td>FY2016</td>
<td>Nippon Steel, Kashima Works</td>
<td>About ¥18 billion</td>
</tr>
<tr>
<td></td>
<td>JFE Steel, East Japan Works, Chiba</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nippon Steel, Kimitsu Works</td>
<td>About ¥29 billion</td>
</tr>
<tr>
<td>FY2017</td>
<td>JFE Steel, West Japan Works, Kurashiki</td>
<td>About ¥18.4 billion</td>
</tr>
<tr>
<td>FY2018</td>
<td>Nippon Steel, Kashima Works</td>
<td>About ¥31 billion</td>
</tr>
<tr>
<td></td>
<td>JFE Steel, East Japan Works, Chiba</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nippon Steel, Kimitsu Works</td>
<td>About ¥33 billion</td>
</tr>
<tr>
<td>FY2019</td>
<td>Nippon Steel, Muroran Works</td>
<td>About ¥13 billion</td>
</tr>
<tr>
<td></td>
<td>JFE Steel, West Japan, Fukuyama Works</td>
<td>About ¥13.5 billion</td>
</tr>
</tbody>
</table>

**2. Planned Updating Projects (5 ovens)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Steel works</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2021</td>
<td>JFE Steel, West Japan Works, Fukuyama</td>
<td>About ¥13 billion</td>
</tr>
<tr>
<td></td>
<td>Nippon Steel, Nagoya Works</td>
<td>About ¥57 billion</td>
</tr>
</tbody>
</table>
(Reference) Unit heat consumption (index) in coke ovens

Heat consumption per ton of coke (The index is set at 100 for fiscal 2005.)

- All coke ovens in operation
- Three coke ovens in eastern Japan
- Coke ovens other than those affected by the Great East Japan Earthquake

1. Eco Process

Updating Coke ovens in FY 2016 (total 3 ovens)
Nippon Steel, Kashima and Kimitsu Works
JFE Steel, East Japan Works, Chiba

Updating Coke ovens in FY 2018 (total 3 ovens)
Nippon Steel, Kashima and Kimitsu Works
JFE Steel, East Japan Works, Chiba
### Major Initiatives implemented or planned since FY2005

#### 1. Next generation coke ovens (Implementing SCOPE21)

<table>
<thead>
<tr>
<th>Implement period</th>
<th>Production capacity</th>
<th>Investment amount</th>
<th>Expected effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kobe Steel Kakogawa Station No. 1</td>
<td>2008</td>
<td>1 million tons /year</td>
<td>About ¥ 37 billion</td>
</tr>
<tr>
<td>Kimitsu Joint Thermal Station No. 6</td>
<td>2013</td>
<td>1 million tons /year</td>
<td>About ¥ 60 billion</td>
</tr>
<tr>
<td>Kashima Joint Thermal Station No. 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wakayama Joint Thermal Station No. 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oita Joint Thermal Station No. 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 2. More efficient power

- Kobe Steel Kakogawa Station No. 1
  - Gas turbine combined cycle unit (2011)
- Kimitsu Joint Thermal Station No. 6
  - Advanced combined cycle unit (2012)
- Kashima Joint Thermal Station No. 5
  - Advanced combined cycle unit (2013)
- Wakayama Joint Thermal Station No. 1
  - Advanced combined cycle unit (2014)
- Oita Joint Thermal Station No. 3
  - Advanced combined cycle unit (2015)
- Kobe Steel Kakogawa Station No. 2
  - Gas turbine combined cycle unit (2015)
- JFE Steel Chiba Station West-No. 4
  - Gas turbine combined cycle unit (2015)
- Nisshin Steel Kure Power Station No. 6
  - Boiler, turbine and generator (planned for 2017)
- JFE Steel Ohgishima Thermal Station No. 1
  - Gas turbine combined cycle (planned for 2019)
- Fukuyama Joint Thermal Station No. 2
  - Gas turbine combined cycle (planned for 2020)

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**Advanced Combined Cycle Power Generation**

Source: Kimitsu Cooperative Thermal Power Company, Inc.
JISF's commitment to a Low Carbon Society has the goal of raising the use of waste plastics and other recycled materials to 1 million tons, assuming the government establishes the necessary collection infrastructure. However, collections totaled 410,000 tons in FY2017, unchanged from FY2005 collections of recycled materials.

A great amount of CO\textsubscript{2} emission reduction is possible by reexamining associated policies for the use of waste plastics and other materials. At government councils and other opportunities, JISF constantly ask for reviews of the current recycling system and revisions as soon as possible.

**Use of Waste Plastics and Other Recycled Materials**

<table>
<thead>
<tr>
<th>Year (FY)</th>
<th>Use of Waste Plastics and Waste Tires (10,000t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>3</td>
</tr>
<tr>
<td>1998</td>
<td>3</td>
</tr>
<tr>
<td>1999</td>
<td>8</td>
</tr>
<tr>
<td>2000</td>
<td>15</td>
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<tr>
<td>2001</td>
<td>27</td>
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<tr>
<td>2002</td>
<td>29</td>
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<tr>
<td>2003</td>
<td>37</td>
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<tr>
<td>2004</td>
<td>42</td>
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<tr>
<td>2005</td>
<td>45</td>
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<tr>
<td>2006</td>
<td>38</td>
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<td>2007</td>
<td>37</td>
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<td>2008</td>
<td>32</td>
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<tr>
<td>2009</td>
<td>35</td>
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<tr>
<td>2010</td>
<td>42</td>
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<tr>
<td>2011</td>
<td>40</td>
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<td>2012</td>
<td>42</td>
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<td>2013</td>
<td>40</td>
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<td>2014</td>
<td>45</td>
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<tr>
<td>2015</td>
<td>44</td>
</tr>
<tr>
<td>2016</td>
<td>45</td>
</tr>
<tr>
<td>2017</td>
<td>47</td>
</tr>
<tr>
<td>2018</td>
<td>41</td>
</tr>
</tbody>
</table>

Full enactment of Japan’s Containers and Packaging Recycling Law
Start of reuse of general waste plastics as products (April 1, 2000)

Source: The Japan Iron and Steel Federation
As for the procurement of plastic packaging and containers, priority is given to material recycling, and therefore, the quantity of plastic packaging and containers bid for and purchased for chemical recycling (using blast furnaces or coke ovens) is showing little growth.

In fiscal 2018, the quantity of plastic packaging and containers bid for and purchased for chemical recycling declined, partly due to revision of the bidding system. (Companies that fail to successfully bid for and purchase plastic packaging and containers designated specifically for material recycling can now bid for plastic packaging and containers designated for general purposes (chemical recycling, etc.).)
For expansion of chemical recycling

- Chemical recycling produces fewer residues than material recycling, and under chemical recycling, almost the whole of materials is recycled. In addition, unit contract prices are low (this means that the recycling-related social cost is low). Chemical recycling is an excellent recycling method.
- Currently, steelmakers can process about 400,000 tons of plastic packaging and containers by using their steel production processes, and they have large available capacities (the operating rate is just over 60%).
- To efficiently promote recycling, it is necessary to promptly revise the existing structure from the following viewpoints.

1. From the standpoint of efficiently and effectively using waste materials (recycling waste materials that are highly effective at cutting CO2 emissions and have a low social cost), the container and packaging recycling system should stop placing priority on recycling materials that produce only small reductions in CO2 emissions.

2. Collection of waste materials should not be restricted to items covered by the Container and Packaging Recycling Law; collecting product plastic waste and other materials too could reduce the need for consumers to discard trash by category and reduce the trash classification expenses for local governments. The government should thus consider enlarging recycling activities to include more types of materials. It is also necessary to consider establishing a pickup system, a quality guarantee system, and a system concerning recycling cost burden on a par with those stipulated in the Containers and Packaging Recycling Law.

Materials Received, Products Sold and Reuse Ratio by Method (FY2018)

<table>
<thead>
<tr>
<th>Fiscal year</th>
<th>Material</th>
<th>Chemical</th>
<th>Material/Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2000</td>
<td>109,300</td>
<td>94,200</td>
<td>86.2</td>
</tr>
<tr>
<td>FY2005</td>
<td>109,300</td>
<td>73,000</td>
<td>66.8</td>
</tr>
<tr>
<td>FY2010</td>
<td>74,498</td>
<td>38,646</td>
<td>51.9</td>
</tr>
<tr>
<td>FY2011</td>
<td>71,583</td>
<td>37,631</td>
<td>52.6</td>
</tr>
<tr>
<td>FY2012</td>
<td>69,789</td>
<td>40,481</td>
<td>58.0</td>
</tr>
<tr>
<td>FY2013</td>
<td>66,401</td>
<td>41,561</td>
<td>62.6</td>
</tr>
<tr>
<td>FY2014</td>
<td>63,377</td>
<td>43,546</td>
<td>68.7</td>
</tr>
<tr>
<td>FY2015</td>
<td>59,561</td>
<td>44,991</td>
<td>75.5</td>
</tr>
<tr>
<td>FY2016</td>
<td>50,652</td>
<td>41,326</td>
<td>81.6</td>
</tr>
<tr>
<td>FY2017</td>
<td>54,897</td>
<td>45,210</td>
<td>82.4</td>
</tr>
<tr>
<td>FY2018</td>
<td>54,945</td>
<td>43,336</td>
<td>78.9</td>
</tr>
<tr>
<td>FY2019</td>
<td>56,406</td>
<td>40,078</td>
<td>71.1</td>
</tr>
</tbody>
</table>

Source: The Japan Containers and Packaging Recycling Association
Activities to Share Best Practices Information in the Steel Industry

- JISF holds meetings that bring together energy personnel of the business sites (blast furnace and EAF) of all member companies at the steel mills of blast furnace steelmakers. These meetings are conducted under the Committee for Expanding the Use of Energy Technology Committees for the purpose of sharing information about effective energy conservation cases that can be made public. Thus far, 77 of these meetings have been held. Normally, about 60 to 70 people participate in these events every year and about 15 presentations are given. Participants come from blast furnace steelmakers and EAF specialty and ordinary steelmakers.

- Information at these events is not limited to equipment updates and replacements, participants also hear about improvements to operations. Every meeting is a valuable opportunity for sharing information and opinions in subject to detailed energy consecration efforts with other participants.

- In FY2019, a meeting was held at the Keihin District of Nippon Steel Oita Works. More than 70 people from blast furnace steelmakers and EAF specialty and ordinary steelmakers attended this event.

A Best Practices Information Meeting

Opening remarks by Mr. Tezuka, Chairman of the Energy Technology Committee
The Research Institute of Innovative Technology for the Earth (RITE) issued a report in 2018 on international comparison of energy efficiency level in steel industry (BF-BOF*). The report revealed that Japan maintains the world’s highest energy efficiency in 2015, as in 2005 and 2010.

**Why is Japan’s steel industry the most efficient?**

- The **penetration rate of energy-saving technologies** is very high in Japan’s steel industry.
- All steelmakers are working on achieving the goals of the JISF’s Commitment to Low Carbon Society and sharing best-practice knowledge among themselves.

In addition to actions in Japan, increasing the use of energy-saving measures and technologies worldwide will be an effective way to further lower CO₂ emissions in the steel industry.
2. Eco Solution
Eco Solution: CO₂ Emission Reduction from Increasing Use of Technologies

- There is much potential for increasing the use of major energy conservation technologies in China, which accounts for almost half of global crude steel production, and India, where steel production is expected to continue to grow.
- Major energy conservation technologies developed and used in the Japanese steel industry are already lowering CO₂ emissions overseas as Japanese companies provide these technologies to other countries. CDQ, TRT and other major types of equipment alone are already lowering annual aggregate CO₂ emissions in China, Korea, India, Russia, Ukraine, Brazil and other countries by 65.53million tons.

Results of potential evaluation for the recovery and efficient use of by-product gases (2015)

<table>
<thead>
<tr>
<th>Country</th>
<th>Coke gas</th>
<th>BF gas</th>
<th>BOF gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>German</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU(28)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Source) This was estimated by RITE on the basis of the IEA energy balance table (for 2017).

Emission Reductions in Other Countries from Japanese Energy-conserving Equipment (FY2018)

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>No. of units</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke dry quenching (CDQ)</td>
<td>106</td>
<td>20.74</td>
</tr>
<tr>
<td>Top-pressure recovery turbines (TRT)</td>
<td>65</td>
<td>11.50</td>
</tr>
<tr>
<td>Byproduct gas combustion (GTCC)</td>
<td>55</td>
<td>23.30</td>
</tr>
<tr>
<td>Basic oxygen furnace OG gas recovery</td>
<td>22</td>
<td>8.21</td>
</tr>
<tr>
<td>Basic oxygen furnace sensible heat recovery</td>
<td>8</td>
<td>0.90</td>
</tr>
<tr>
<td>Sintering exhaust heat recovery</td>
<td>6</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Total emission reduction: 65.53Mt

Ref: Total emission reduction in FY2017 was 62.59Mt - CO₂/year

Energy conservation potential through the spread of major energy conservation technologies

(Source) This chart was created by referring to Arens et al. (2017) for Germany, JISF (2017) for Japan, Schulz et al. (2015) for South Korea, and China Steel Yearbook (2016) for China.

※CDQ: Coke Dry Quenching
TRT: Top Pressure Recovery Turbines
GTCC: Gas Turbine Combined Cycle system
International Collaboration for the Support of Eco Solutions

- Under certain circumstances, energy-conservation equipment supplied to users worldwide by Japanese engineering companies has the potential to reduce annual CO₂ emissions by 70 million tons in 2020 and 80 million tons in 2030. This is equivalent to more than 40% of all CO₂ emissions of the Japanese steel industry.
- In India and other emerging countries where steel production will continue to climb, the use of energy-conservation facilities as standard equipment at newly constructed steel mills could prevent discharging annual CO₂ emissions of approximately 10 million tons. Consequently, eco solutions can be an extremely effective way to fight against global warming.

Japan-China Steel Industry Environmental Protection and Energy Conservation Technology Conference (2005~)

The Public and private collaborative meeting between Indian and Japanese Iron and Steel Industry (2011~)

ASEAN-Japan Steel Initiative (2014~)

APP Steel TF (2006~2010)
APP: Asia Pacific Partnership

GSEP Steel WG(2010~2015)
GSEP: Global Superior Energy Performance Partnership

ENCO (~2009)
Environment Committee

EPCO (2010~2013)
Environmental Policy Committee

ECO (2014~)
Environment Committee

“CO₂ Breakthrough Program”: Participating with COURSE50 (2003~)

CO₂ data collection (2007~)

Development of ISO14404* (2009~)
Versions for integrated steel plants and EAF issued in 2013, version for DRI-EAF in 2017
*International standard for the calculation of CO₂ emission from steel plants
3. Eco Product
Japanese manufacturers have taken the lead in developing and commercializing many highly efficient industrial products. Examples include fuel-efficient automobiles and highly efficient power generation equipment and transformers. These products have made a big contribution to conserving energy and cutting CO$_2$ emissions in Japan and worldwide.

The Japanese steel industry has established a close relationship with these manufacturers by developing and supplying steel that has a variety of characteristics. This high-performance steel is a vital to achieving the outstanding functions of advanced products and has earned a reputation for reliability among manufacturers.

**Eco Product: Japanese Industrial Products that Conserve Energy and Cut CO$_2$ Emissions**

- **Airplane components**
  - Strong and durable jet engine shafts further boost maximum thrust = Longer range, better fuel efficiency

- **Motors for hybrid/electric cars**
  - High-efficiency non-oriented electrical sheets for higher fuel efficiency, more power, smaller size and lower weight

- **Automotive and industrial machinery parts**
  - Strong gear steel increases gears and reduces size and weight – higher fuel efficiency

- **Boiler tubes**
  - Steel tubes that resist high temperatures and corrosion make power generation more efficient

- **Suspension springs**
  - Higher strength steel for valve and suspension springs used in punishing applications makes vehicles lighter and lowers fuel consumption

- **Generator parts**
  - Steel for high-efficiency power plant turbines can withstand high temperatures and high rotation speeds
To establish a method to determine the quantitative contribution of high-performance steel, JISF established in FY2001 a committee with the participation of associations of steel-consuming industries, The Institute of Energy Economics, Japan and the Japanese government. The committee has been monitoring contributions every year since then.

Statistics are for the five major types of high-performance steel for which quantitative data are available (FY2018 production of 6.97 million tons, 6.8% of Japan’s total crude steel output). The use of finished products made of high-performance steel cut FY2018 CO₂ emissions by 10.10 million tons for steel used in Japan and 20.96 million tons for exported steel, a total of 31.06 million tons of CO₂.

**CO₂ Emission Reductions by the five major types of high-performance steel (FY2018)**

<table>
<thead>
<tr>
<th></th>
<th>1. Domestic</th>
<th>2. Export</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automobiles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power generation boilers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ships</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO₂ reduction</td>
<td>10.10 Mt-CO₂</td>
<td>20.96 Mt-CO₂</td>
</tr>
</tbody>
</table>

**CO₂ Emission Reductions:** 31.06 million tons CO₂ in total (6.97 million tons of high-performance steel)

Source: The Institute of Energy Economics, Japan

*The five categories are automotive sheets, oriented electrical sheets, heavy plates for shipbuilding, boiler tubes and stainless steel sheets. In FY2018, use of the five categories of steel products in Japan was 3.53 million tons and exports were 3.44 million tons for a total of 6.97 million tons.

*Assessments in Japan started in FY1990 and for exports assessments started in FY2003 for automobiles and shipbuilding, in FY1998 for boiler tubes, and in FY1996 for electrical sheets.
Iron and steel materials have greatly improved their mechanical and electromagnetic properties. However, the characteristic level we put into practical use is only 1/10-1/3 (in the case of strength) with respect to the theoretical limit value.

Japan Iron and Steel Industry will contribute to the reduction of CO2 in the entire life cycle, while supporting the foundation of the future society, through not only further strengthening steel products but also developing next-generation steel products for hydrogen infrastructure to be expected in the future.
Eco Product Contribution: Quantitative Evaluation of Contribution of High Strength Sheets for Automobiles

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. High strength steel sheets for automobiles are steel sheets that can be thinned out while maintaining high strength (and thus reducing steel product weight). Automobiles using this material are lighter than those using conventional steel sheets without such features, thus leading to fuel efficiency improvements that enable CO₂ emission reductions during operation.

Quantification results of avoided emissions

Avoided emissions at the in-use stage of high-strength steel sheets for automobiles in FY2017 were as provided below:

- Domestic use: 4.5 million t-CO₂
- Exports: 8.49 million t-CO₂
- Total: 12.99 million t-CO₂

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = Number of new cars manufactured × Average travel distance × Fuel efficiency improvement rate / Average fuel efficiency of new cars × Average years in use

(1) Baseline scenario and assumptions

- **Baseline scenario**
  The case study assessed CO₂ emission reductions from improving fuel efficiency at the in-use stage of automobiles by replacing steel sheets without special functions (normal steel), which serve as the baseline, with high strength steel sheets up to the current share.

<table>
<thead>
<tr>
<th>Source</th>
<th>Assessed steel sheets (YS340)</th>
<th>Assessed results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobiles</td>
<td>Normal steel</td>
<td>Energy savings due to reducing steel sheet weight</td>
</tr>
</tbody>
</table>

- **Assumptions**
  High-strength steel sheets can be made thinner than baseline normal steel while maintaining high strength; and therefore, automobiles using this material are lighter than those using conventional steel sheets without such properties, thus leading to fuel efficiency improvements that enable CO₂ emission reductions during operation. (Quantifications are estimates based on actual data.)

(2) Scope of quantification

- **Target steel sheets**
  Steel sheets used domestically and exported steel. (Steel exports from 2009)
  The case study covered only steel manufactured in Japan, and excluded overseas manufacture. (Japanese steel manufacturers do not possess integrated steelworks overseas.)

- **Target stages**
  The case study assessed CO₂ emission reductions due to fuel efficiency improvements at the in-use stage of automobiles.
  As raw material mining and transport account for a minuscule percentage of the entire life cycle of iron and steel, and also because the assessment involves replacing steel products, little change is seen at the manufacturing stage.
  When assessing the effect of reducing the weight of steel, CO₂ emissions from raw material mining and transport become less than the baseline in accordance with the reduced amount of steel used, but the Federation includes only the in-use stage in its quantifications.

(3) Assessment period

From the viewpoint of comparing CO₂ emissions from a manufacturing process during one fiscal year, the case study performed a cross-sectional assessment of stock.

(4) References

- Papers on the method of analysis have been published on the Institute of Energy Economics, Japan website:
  - Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspective: Overview (Japanese) [Link](https://enkom.ineoj.or.jp/data/pdf/62.pdf)
  - Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Study 3, Automobiles (high strength steel sheets) (Japanese) [Link](https://enkom.ineoj.or.jp/data/pdf/45.pdf)
  - Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (English) [Link](https://enkom.ineoj.or.jp/en/data/pdf/115.pdf)
  - Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (English) [Link](https://enkom.ineoj.or.jp/en/data/pdf/172.pdf)
Eco Product Contribution: Quantitative Evaluation of Contribution of High Tensile Strength Plates for Vessels

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. High tensile plates for vessels are steel plates that can be thinned out while maintaining high strength (and thus reducing steel product weight). Vessels using this material are lighter than those using conventional steel sheets without such features, thus leading to fuel efficiency improvements that enable CO₂ emission reductions during operation.

Quantification results of avoided emissions

Avoided emissions at the in-use stage of high tensile plates for vessels in FY2017 were as provided below:
- Domestic use: 1.94 million t-CO₂
- Exports: 0.61 million t-CO₂
- Total: 2.55 million t-CO₂

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = Fuel consumed by vessels / (1 - Weight reduction rate of operating vessels × Contribution ratio to fuel savings) × (Weight reduction rate of operating vessels × Rate of contribution to fuel savings) × Calorific value of fuels

Source: Japan Business Federation, “Contributing to Avoided Emissions through the Global Value Chain”

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. Heat-resistant high strength steel tubes for generating boilers can resist higher temperatures than conventional heat-resistant steel tubes, and can thus improve the power generation efficiency of steam power plants. This leads to CO₂ emission reductions from fuel consumption savings.

Quantification results of avoided emissions

Avoided emissions at the in-use stage of heat-resistant tubes for generating boilers in FY2017 were as provided below:
- Domestic use: 0.96 million t-CO₂
- Exports: 4.30 million t-CO₂
- Total: 5.26 million t-CO₂

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = Fuel savings due to efficiency improvements achieved at 593°C – 600°C-class steam power plants as a result of shifting from 566°C-class steam power plants × Rate of contribution of high-performance heat-resistant tubes, or 25% × Number of years power plants are in service

Source: Japan Business Federation, “Contributing to Avoided Emissions through the Global Value Chain”
3. Eco Product

Eco Product Contribution: Quantitative Evaluation of Contribution of Grain-oriented Sheets for Transformers

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. Current grain-oriented silicon steel sheets for transformers can reduce iron loss (energy loss) during transformation; and therefore contribute to efficient electric power transmission, and thus CO₂ emission.

Quantification results of avoided emissions

Avoided emissions at the in-use stage of grain-oriented silicon steel sheets for transformers in FY2017 were as provided below:

Domestic use: 2.15 million t CO₂
Exports: 6.51 million t CO₂
Total: 8.66 million t CO₂

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = minimum value \times (Transformer no-load losses per unit capacity in an assessment year \times Transformer no-load losses per capacity 30 years ago) \times Hours of use

Source: Japan Business Federation, “Contributing to Avoided Emissions through the Global Value Chain”
Eco Product Contribution: Quantitative Evaluation of Contribution of Stainless Steel Sheets for Railway Cars

Source: Japan Business Federation, “Contributing to Avoided Emissions through the Global Value Chain”
4. Promotion of CO2 Ultimate Reduction System for Cool Earth 50 Development (COURSE50)
Project summary
Work is under way on developing a technology for using hydrogen for the reduction of iron ore (method for lowering blast furnace CO₂ emissions). Hydrogen in the very hot coke oven gas (COG) generated during coke production is amplified and then used to replace some of the coke. Furthermore, for the separation of CO₂ from blast furnace gas (BFG), a revolutionary CO₂ separation and collection technology (technology for separating and collecting CO₂ from blast furnaces) will be developed that utilizes unused heat at steel mills. The goal is to use these technologies for low-carbon steelmaking that cuts CO₂ emissions by about 30%. (a project for NEDO)
5. Reference
ISO 50001 is an international standard for energy management systems that was issued in June 2011.

On February 20, 2014, JISF became the first industrial association in the world to receive ISO 50001 certification, the result of global warming and energy conservation measures associated with the voluntary action plan and the Commitment to a Low Carbon Society.

This certification is proof that the voluntary actions of the steel industry are sufficiently transparent, reliable and effective in relation to the requirements of international standards.

**Eco Solution: ISO50001 Certification**

**JISF Energy Management System**

- **Plan**
  - JISF establishes the highest possible goals based on available technologies
  - Suitability of the plan is confirmed by providing explanations during the target establishment process to the government advisory council and the Keidanren third-party evaluation committee.

- **Do**
  - Member companies take actions for conserving energy and cutting CO2 emissions based on JISF targets
  - JISF checks progress by receiving reports from company presidents at its Executive Board Meeting

- **Action**
  - The plan is revised as needed based on assessments and instructions from the government advisory council (steel working group) and Keidanren third-party evaluation committee

- **Check**
  - Performance is evaluated every year by a government advisory council (steel working group) and Keidanren third-party evaluation committee

**ISO50001 Certificate**
Investments for Environmental Protection and Energy Conservation

- Japanese steel industry made investments of about ¥3 trillion between FY1971 and FY1989 for environmental protection and energy conservation. These investments totaled about ¥1.8 trillion between FY1990 and FY2012.
- Investments for rationalization and labor-saving totaled about ¥1.8 trillion between FY2005 and FY2018.

Fig. Accumulative investment for environmental facilities since FY1971

Fig. Accumulative investment for rationalization and labor-saving since FY1999

Source: Development Bank of Japan Inc

# Energy Conservation Initiatives of the Steel Industry

<table>
<thead>
<tr>
<th>Decade</th>
<th>Initiatives</th>
</tr>
</thead>
</table>
| ‘70s   | 1) Process innovations (Continuous casting, continuous annealing, etc.)
|        | Process improvements (Hot charge rolling, automated combustion control, etc.)
|        | 2) Recovery and efficient use of byproduct gases (Gas holder, high-efficiency gas turbine combined cycle generation, etc.)
|        | 3) Exhaust heat recovery (TRT, (CDQ), etc.)
| ‘80s   | 1) Process innovations (Continuous casting, continuous annealing, etc.)
|        | Process improvements (Hot charge rolling, automated combustion control, etc.)
|        | 2) Recovery and efficient use of byproduct gases (Gas holder, high-efficiency gas turbine combined cycle generation, etc.)
|        | 3) Exhaust heat recovery (TRT, (CDQ), etc.)
| ‘90s   | 1) Process innovations (Continuous casting, continuous annealing, etc.)
|        | Process improvements (Hot charge rolling, automated combustion control, etc.)
|        | 2) Recovery and efficient use of byproduct gases (Gas holder, high-efficiency gas turbine combined cycle generation, etc.)
|        | 3) Exhaust heat recovery (TRT, (CDQ), etc.)
|        | SCOPE-21 (Blast furnace coal powder input, coal moisture control, etc.)
| ‘00s   | Constant improvements (Artificial intelligence, supply chain network, etc.)
| ‘10s   | Hydrogen amplification, CO₂ recovery (Recovery of mid/low-temp. exhaust heat)
|        | Waste material use (Waste plastics and tires, gasification, etc.)

**SCOPE-21**

- Process innovations
- Process improvements
- Exhaust heat recovery
- Byproduct gas use
- Waste material use

**Diagram**

- Total energy consumption
- Net consumption
- Recovered
- Process innovations
- Process improvements
- Exhaust heat recovery
- Byproduct gas use
- Waste material use
International Comparison of Energy Efficiency in the Steel Industry

- According to the IEA, Japan has the world’s smallest potential for energy conservation per ton of crude steel. According to RITE, Japan has the world’s most energy efficiency steel industry. These figures demonstrate that virtually all steel mills in Japan use existing technologies and that there is very little potential for further energy-conservation measures.


Source: IEA “Energy Technology Perspective 2014”

Estimate of Steel Industry (BF-BOF) Energy Efficiency (2015, Japan=100)

Source: RITE “Estimated Energy Unit Consumption in 2015”

Japan has the world’s highest energy efficiency.
Crude Steel Output and Total and Unit CO$_2$ Emissions

Crude Steel Output and CO$_2$ Emissions
(constant FY2005 electric power emission coefficient)

Crude Steel Output and Unit CO$_2$ Emissions
(constant FY2005 electric power emission coefficient)
As of end of 2015, the per capita steel stock in Japan was 10.7 tons compared with 4.0 tons worldwide.

Steel stock per capita is an indicator of the penetration of social infrastructure and industrial products, which are a measure of prosperity. The steel stock is expected to grow steadily in emerging countries as these countries become more prosperous and accomplish Sustainable Development Goals (SDGs).

Global crude steel output will increase for many more years

India’s steel industry plans to approximately triple crude steel output to 300 million tons by 2030.

Global Crude Steel Output

Source: worldsteel

India: Goal is annual crude steel production capacity of 300 million tons by 2030-31
The Japanese Steel Industry’s Overseas Contributions to Energy Conservation

   • This conference has been held periodically since steel industry leaders of the two countries signed an MoU in July 2005. Providing a forum for exchanges of information about steel technologies, this conference plays a key role in international steel industry cooperation.
   • The 11th conference was held in Taiyuan, China’s Shanxi Province, in October 2019. It has been over 10 years since the first conference was held. It has been confirmed that Chinese mills have advanced greatly in terms of environmental protection and energy conservation measures, and this event has helped Chinese mills undertake relevant measures.

2. India: Public and Private Collaborative Meeting between the Indian and Japanese Steel industries (2011~)
   • Started in 2011, this meeting has been held eight times, bringing together public and private-sector energy conservation experts in the two countries.
   • The Japanese steel industry has provided assistance concerning the introduction of its energy conservation technologies in India. Activities include steel plant diagnosis using ISO14404, the establishment of a Technologies Customized List containing energy conservation technologies suitable for India, and technology seminars held by Japanese manufacturers of energy conservation equipment.

3. ASEAN: ASEAN-Japan Steel Initiative (2014~)
   • Started in February 2014, this initiative brings together steel industry energy conservation professionals from Japan and six ASEAN countries. Since the start of this initiative, workshops for specific themes have been held for the ASEAN region and individual countries to support energy conservation measures in the ASEAN steel industry.
   • There have been steel plant diagnosis at 14 ASEAN steel mills in order to provide advice for improving operations and using new technologies.
The Technologies Customized List for India

The Technologies Customized List contains information about technologies involving energy conservation and protecting the environment that are recommended for specific countries and regions. These lists have been prepared for India and the ASEAN region.

35 recommended technologies
(33 techs for Bf-BOF and 34 techs for EAF)

Energy conservation benefits, technology suppliers and other information

Technology Explanation Sheets
Thorough explanations of individual technologies

Steel Plant Diagnosis

**Objective**

1. Evaluate energy efficiency level of the steel plant using ISO14404*.
2. Recommend energy saving technologies from Technologies Customized List (TCL) based on the equipment diagnosis to encourage technology transfer from Japan

*ISO14404 is an international standard for calculating CO2 emissions from a steel plant.

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**Day1~3**

1. **Operation observation** of BF-BOF, EAF, reheating furnace and other facilities

2. **Energy data collection** by using ISO14404

---

**Day4**

3. **Reporting session**
   
   Based on ISO14404, Japanese experts
   1. analyze energy consumption trend
   2. recommend suitable energy saving technologies mainly from TCL
   3. provide advice for operational improvement

---

The steel plant diagnosis has been performed at 26 locations.
- 12 plants in India
- 14 plants in the ASEAN region in 6 countries*

*Indonesia, Singapore, Thailand, Philippines, Vietnam, Malaysia
The Importance of Increasing the Use of Eco Product

- High-performance steel generally has higher CO\textsubscript{2} emissions than ordinary steel does during the manufacturing stage. But high-performance steel is an eco product because it greatly lowers CO\textsubscript{2} emissions when used by making finished products more energy efficient.
- By supplying high-performance steel, the Japanese steel industry is making a big contribution to energy conservation and cutting CO\textsubscript{2} emissions in Japan and around the world. Furthermore, this steel supports “green” economic growth in Japan and creates jobs as the steel is exported to users worldwide.
- Global demand for electricity and motor vehicles is certain to increase as economic growth continues, chiefly in emerging countries. Demand for high-performance steel is expected to become even greater as a result. Meeting the need for high-performance steel will therefore be critical from the standpoints of supporting Japan’s economic growth and protecting the global environment.

Asia/Global Energy Outlook 2015 by The Institute of Energy Economics, Japan

Source: The Institute of Energy Economics, Japan
Eco Product: The global competitive edge of the Japanese steel industry, mainly for high-performance steel

- Steel from other countries cannot match Japan’s high-performance steel in terms of performance, quality, supply and other attributes. High-performance steel is the core element of the international competitive edge of the Japanese steel industry.
- China, the world’s largest steel producer, became a net exporter of steel in 2006. Only Japan is the only net exporter of steel to China now.
Mixed cement (mainly slag cement) is one way to lower CO$_2$ emissions related to energy consumption. The use of this cement is growing and a further increase in the production ratio of mixed cement could significantly lower CO$_2$ emissions.

Replacing conventional cement (Portland cement), which generates CO$_2$ during the firing of raw materials, with slag cement, which does not generate CO$_2$ during production, reduced annual CO$_2$ emissions by 10.71 million tons/year (FY18).

- **Japan:** Annual reduction of 3.36 mn tons of CO$_2$
- **Exports:** Annual reduction of 7.08 mn tons of CO$_2$

Assumptions for emission reduction contribution:
- Conversion to volume of cement: 450kg of slag/Ton of cement
- CO$_2$ emission reduction: 312kg of CO$_2$/Ton of cement

Source: Japan Cement Association, Nippon Slag Association
Initiatives in the cargo transport sector

- CO₂ emissions per unit of cargo transport decreased to 42.0kg of CO₂/k ton-km in FY18 from 44.0kg of CO₂/k ton-km in FY06.
- In FY18, the steel industry modal shift (ships + rail) was 76% for primary transportation and 96% for cargo transported more than 500km. This is far higher than the average modal shift rate of 38.1% for all industries in Japan (Ministry of Land, Infrastructure and Transport FY05 data for more than 500km).
- Steelmakers are taking other actions too, such as improving cargo transport efficiency by using a higher pct. of cargo space on ships, utilizing shore-based electric power supplies for ships and using eco-tires on trucks and using eco-friendly driving methods.

![CO₂ Emissions per Unit of Cargo Transport](image)

**Fuel saving by using electricity from shore-based sources**

Cuts fuel oil use by 70% to 90% while ships are docked

<table>
<thead>
<tr>
<th>No. of units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel mills</td>
</tr>
<tr>
<td>Junction port</td>
</tr>
</tbody>
</table>

(Totals for 4 blast furnace and 2 EAF steelmakers as of the end of FY18)

Use of binary power generation systems for ships

[Effects and characteristics]
- Power is generated by using waste heat from the conventionally disposed main engine of a ship as a heat source.
- The power generated is used effectively as a supplemental power source for the ship. This contributes to reducing fuel used for generator engines and CO₂ emissions.

[Example of use of a binary power generation system]
Kobe Steel and Kawasaki Kisen Kaisha have jointly installed a binary power generation system on a coal ship, and the ship has been in operation since February 2019.
Initiatives in commercial/residential sector

- In FY2005, Japan’s steelmakers started energy conservation programs using environmental ledgers for residential sector. Steelmakers started education programs that included all employees, including at group companies, promotion of use of household environmental ledgers, and other actions. There are around 19,000 households participating in this program in FY2018.

- Steel industry is taking actions to reduce energy consumption and CO₂ emission from offices. Unit energy consumption in offices in 2017 were down 25% compared to FY 2008-2012.

Household CO₂ Emissions
(CO₂ emissions per individual: kg of CO₂/person-year)

Data for 309 business sites of 69 companies in FY2018

Source: Estimates based on Greenhouse Gas Inventory Office materials
Notes:
1. Total for Japanese households includes households and household use of automobiles.
2. Total for steel industry households is an estimate by JISF based on the inventory in Japan.
Example of use of unused energy in nearby locations

Supply of heat to sake companies by a steelmaker in the Kobe area

Equipment to supply heat to sake companies

Features of the heat source system
1. Supply of heat source
   Steam from a power plant is used as the heat source.

2. Energy conservation
   Energy use is down 30% from when each company had its own boiler. Part of steam used for power generation is drawn off from between turbines and supplied in order to reduce energy lost to cooling water.

Equipment

<table>
<thead>
<tr>
<th>Steam generators</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam generation:</td>
<td>40 tons/hour</td>
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<tr>
<td>Heating capacity:</td>
<td>29.5GJ</td>
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<tr>
<td>Thermal transmission area:</td>
<td>382m²</td>
</tr>
<tr>
<td>Primary steam pressure:</td>
<td>1.01MPa (saturation temperature)</td>
</tr>
<tr>
<td>Secondary steam pressure:</td>
<td>0.837MPa (saturation temperature)</td>
</tr>
</tbody>
</table>

Water softener: 1 set

Water supply method: Two-pipe system with direct-buried steam (300-150A) and recirculated water (50A) (24-hour supply all year)
Phase 1, Step 2 (FY13-17) Initiatives

Development item (a): Technology for reducing blast furnace CO₂ emissions
To develop this technology, a 10m³ blast furnace was constructed for testing. Comprehensive trials were performed to verify the results of laboratory research conducted during Phase 1, Step 1. One goal is to create a reaction control technology that maximizes the effectiveness of hydrogen reduction. Another is to obtain data for increasing the scale for phase 2 tests using the demonstration test blast furnace.

Development item (b): Collection of CO₂ from blast furnace gas
The goal is to develop a technology that makes it possible to collect CO₂ at a cost of ¥2,000 per ton of CO₂, which is the cost that matches the requirements of the demonstration test blast furnace. This will require developing a high-performance chemical absorption liquid and other substances, creating a more efficient physical adsorption method, performing applied research for technologies for utilizing exhaust heat, and creating technologies for more cost reductions.

(a) Technology for reducing blast furnace CO₂ emissions
(b) Technology for collecting CO₂ from blast furnace gas

\[(a)+(b) = \text{CO}_2\text{ reduction target is about 30%}\]
Overview of results in FY 2018

(1) Development of technology to use hydrogen at blast furnaces
   - To put into practical use a technology to use hydrogen as a partial alternative for coke for iron ore reduction, a total of five test runs were conducted. As a result, the effects of the amount of hydrogen injected from the tuyere through the control of ventilation and raw materials on the operation of the blast furnace were confirmed.
   - Three-dimensional mathematical models were used to predict complex reactions inside the blast furnace, and test runs were conducted with an increased amount of hydrogen.

(2) Development of technology to separate and recover CO₂ from blast furnace gas
   - To further reduce separation and recovery energy per ton of CO₂ based on chemical absorption, the performance of the mixed-solvents absorbents was improved, the cost of the absorbent solution was reduced, and the operational conditions were optimized.
   - As for the technology to use unused waste heat from steel plants, to develop a heat recovery system that can maintain heat conductivity capabilities for a long period of time, the properties of emitted gases were inspected. In this manner, studies were conducted for an exhaust heat recovery system.

Test blast furnace
(Nippon Steel, Kimitsu Works)
Hydrogen reduction iron making (A challenge towards Zero-carbon STEEL)

- Nov, 2018: Release of “long-term vision for climate change mitigation - A challenge towards Zero-carbon STEEL-


- Dec, 2019: In the supplementary budget proposal for fiscal 2019, 3.7 billion yen was allocated under programs to accelerate the Progressive Environment Innovation Strategy, including projects for “Zero-carbon STEEL”. (The supplementary budget was passed on January 30, 2020.)

- Jan, 2020: The Progressive Environment Innovation Strategy, which was determined by the government’s Integrated Innovation Strategy Promotion Council, included descriptions about “Zero-carbon STEEL”.

Roadmap towards Zero-carbon STEEL

Excerpted from the public relations material for the supplementary budget for fiscal 2019 concerning the Ministry of Economy, Trade and Industry
化石化資源依存からの脱却（再生可能エネルギー由来の電力や水素の活用）

水素還元製鉄技術等による「ゼロカーボン・スチール」の実現

【目標】
・2050年以降のできるだけ早い時期までに、現在の高炉法による鋼鉄製造と同等のコストで「ゼロカーボン・スチール」を実現する水素還元製鉄技術等の超革新技術の開発を行う。実用化には、2050年の水素コスト（プラント引渡しコスト）20円/Nm³という目標をさらに下回る水準でCO₂フリー水素が安定的かつ大量に供給されることが必要。世界のCO₂削減量は約38億トン。¹

【技術開発】
・「ゼロカーボン・スチール」の実現には長期的な研究開発が必要となるため、現状の高炉法における低炭素化、省エネルギー対策も重要となる。そのため、COURSE50やフェロコース技術の開発を引き続き行い、2030年頃の実用化を目指す。
・COURSE50及びフェロコースの開発で得られる知見を足掛かりとして、「ゼロカーボン・スチール」の実現に向けた更なる革新技術を検討する。このため更なる革新技術に関する研究開発を実施し、高炉法による水素還元の拡大技術（COURSE50技術の拡大）、直接還元法による水素還元製鉄技術、CCUS等の技術開発や実用化における諸課題の抽出等を行う。当該結果を踏まえ、ナショナルプロジェクトによる支援の下に「ゼロカーボン・スチール」を実現する革新技術開発を進める。

（実施体制）
・国際的な競争領域であるため、国内鉄鋼メーカーを中心とした連携により技術開発を進める。

©）NEDO TSCで試算。 (CCUSによる削減を含む)  CCU：製鉄所が源CO₂の有価化
**Commitment to JISF’s Low Carbon Society Phase II**

**Eco Process**
Aiming 9 million-tons CO$_2$ reduction vs BAU emission in FY2030 by fully implementing state-of-the-art energy technologies

**Eco Solution**
Contribute worldwide by transferring the world’s most advanced energy-saving technologies to other countries (especially to developing countries) and increasing the use of these technologies. (Ca. 50 million ton of CO$_2$ reduction contribution in FY2013. Ca. 80 million tons of estimated CO$_2$ emission reduction contribution in FY2030)

**Eco Product**
By supplying the high-performance steel that is essential to create a low-carbon society, contribute to lowering emissions when finished products using this steel are used. (Ca. 26 million tons of CO$_2$ emission reduction contribution in FY2013. Ca. 42 million tons of estimated CO$_2$ emission reduction contribution in FY2030.)

**Development of revolutionary processes (COURSE50)**
Cut CO$_2$ emissions from production processes about 30% by using hydrogen for iron ore reduction and collecting CO$_2$ from blast furnace gas. The first production unit is to begin operations by about 2030*. Goal is widespread use of these processes by about 2050 in line with timing of updates of existing blast furnace facilities.

**Development of innovative ironmaking process (Ferro Coke)**
Develop ferro-coke that can speed up and lower the temperature of the reduction reaction inside a blast furnace and create the associated operating process. Develop revolutionary technologies that can reduce energy consumption for pig iron production and permit the greater use of low-grade raw materials.
The 2030 goal for steel production processes is to use advanced technologies as much as possible to lower CO₂ emissions by 9 million tons compared with the volume of these emissions (BAU emission volume) expected from each production volume figure*1 (but excluding the improvement in the electricity coefficient).

<table>
<thead>
<tr>
<th>Actions</th>
<th>Phase II 2030</th>
<th>Phase I 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Improve coke oven efficiency</td>
<td>About 1.3mn tons of CO₂</td>
<td>About 0.9mn tons of CO₂</td>
</tr>
<tr>
<td>(2) More efficient electricity</td>
<td>About 1.6mn tons of CO₂</td>
<td>About 1.1mn tons of CO₂</td>
</tr>
<tr>
<td>generation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) More energy conservation</td>
<td>About 1.5mn tons of CO₂</td>
<td>About 1.0mn tons of CO₂</td>
</tr>
<tr>
<td>(4) Waste plastics*2</td>
<td>2.0mn tons of CO₂</td>
<td>–</td>
</tr>
<tr>
<td>(5) Develop and use revolutionary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>technologies*3</td>
<td>About 2.6mn tons of CO₂</td>
<td>–</td>
</tr>
<tr>
<td>Total</td>
<td>9mn tons of CO₂</td>
<td>3mn tons of CO₂ +</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waste plastics*4</td>
</tr>
</tbody>
</table>

These reductions do not include the effect of changes in the electric power emissions coefficient.

Fiscal 2030 Assumption

<table>
<thead>
<tr>
<th>Crude steel output in Japan (10,000 tons)</th>
<th>Participants' Crude steel output (10,000 tons)</th>
<th>BAU emissions (tons of CO₂)</th>
<th>Emissions after target is reached (tons of CO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12,000</td>
<td>11,508</td>
<td>19,733</td>
<td>18,833</td>
</tr>
</tbody>
</table>

*1 These targets are based on total crude steel production of 120 million tons in Japan, plus or minus 10 million tons. Emission reductions may be more or less than the anticipated range if there is a significant change in production volume. If there is a significant change, the suitability of the BAU figure and emission reduction will be reexamined in accordance with the actual production level.

*2 Points concerning increasing the use of waste plastics and other waste materials
  a. Awaiting results of studies concerning a Japanese government review of the container, packaging and plastic recycling system and other related items; may be reviewed (target reduced) if there is no outlook for growth in the waste materials handling capacity of the steel industry by FY2030 in relation to the actual FY2005 capacity.
  b. In addition, for the reduction target incorporated in the FY2020 target, awaiting results of a Japanese government study of the recycling system; may be reviewed (target reduced) if there is no outlook for growth in waste materials handling capacity by FY2020 in proportion to the above target.

*3 For the development and use of revolutionary technologies, assumptions are that (a) technologies will be in use in FY2030 and (b) the use of these technologies is economically feasible. In addition, for COURSE50, assumptions are that an international equal footing is established and the necessary social infrastructure is created, including the site selection and establishment of a storage facility for government-led carbon capture and sequestration programs. Targets will be reexamined if these conditions are not fulfilled.

*4 Within the target for the 5 million ton reduction in CO2 emissions in FY2020, the primary focus is on a 3 million ton reduction in CO2 emissions by steelmakers’ own initiatives for efficient use of energy and other ways. Concerning collection of waste plastics and other ways, only an increase in the collected volume compared to FY2005 is counted as the amount of reduction in emissions.
Steel Production Processes and Development and Use of Energy Conservation Technologies

Coal moisture control equipment
Coke dry quenching equipment
SCOPE21
Reuse of waste plastics

Coal
Coke oven
Pellet plant
Blast furnace
Torpedo car
LD converter
LD converter gas
Oxygen

BDG

Cold rolling mill
Hot rolling mill
Heating furnace
Heating furnace with regenerative burner

Prevention of air leakage
More efficient main exhaust blowers
Suitable size for dust collection blowers
Control of electric motor speed

Cut electricity consumption by dust collectors
Suitable volume for cooling pumps
(small and lower lifting)

Prevention of pressure loss for input/exhaust
Thermal insulation for blower pipes

Construction of high recovery rate plants
More efficient raw material air compressors

Use less power for lights
(Use sodium lamps, separate power supplies, etc.)

More LDG recovery by expanding sources
Control of LD-IDF rotation speed
Temperature retention on billet transport line
Cut electricity consumption by dust collectors
Suitable volume for cooling pumps
(smaller and lower lifting)

More efficient recuperator
Modify ovens (increase length, use partitions to improve heat transmission, increase oven thermal insulation, better seals for input/output doors)
Improve thermal insulation for skid pipes
Improve heat pattern
Measures for low-temperature billet output (temperature retention on transport table, etc.)

Efficient continuous annealing
Continuous electroplating equipment

Electricity

Bloom
Slab

Electric power plant
High-efficiency power generation
ACC USC

5. Reference – Production Process
### Change in Product Mix for Downstream Evaluations

#### Fiscal year

<table>
<thead>
<tr>
<th>Year</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
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<tbody>
<tr>
<td>2000</td>
<td>144</td>
<td>381</td>
<td>354</td>
<td>316</td>
<td>263</td>
<td>424</td>
<td>448</td>
<td>484</td>
<td>423</td>
<td>514</td>
<td>609</td>
</tr>
<tr>
<td>2001</td>
<td>381</td>
<td>316</td>
<td>263</td>
<td>514</td>
<td>609</td>
<td>423</td>
<td>484</td>
<td>448</td>
<td>424</td>
<td>316</td>
<td>381</td>
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<td>2002</td>
<td>316</td>
<td>263</td>
<td>424</td>
<td>381</td>
<td>354</td>
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<td>263</td>
<td>424</td>
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<td>2003</td>
<td>263</td>
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<td>316</td>
<td>263</td>
<td>424</td>
<td>448</td>
<td>484</td>
<td>514</td>
</tr>
<tr>
<td>2004</td>
<td>424</td>
<td>316</td>
<td>263</td>
<td>424</td>
<td>354</td>
<td>316</td>
<td>263</td>
<td>424</td>
<td>448</td>
<td>484</td>
<td>514</td>
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</tbody>
</table>

#### Production volume ratio

<table>
<thead>
<tr>
<th>Economic category</th>
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<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
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<tbody>
<tr>
<td>Steel plates and piling</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rails, tires and rolled wheels</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4 Bars</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>3 Sections</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>2 Steel plates and piling</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1 Rails, tires and rolled wheels</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0 Net exports of semi-finished products</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>14 Galvanized sheets</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>13 Tin-free steel</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>12 Tinplate</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>11 Cold-rolled electrical sheets</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10 Cold-rolled sheets</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>9 Hot-rolled strips, export high-tensile-strength steel</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8 Steel sheets, medium/thin</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
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<td>7 Heavy plates, export high-tensile-strength steel</td>
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<td>1</td>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>6 Special steel wire rod</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5 Ordinary wire rod, bar-in-coil</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4 Bars</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2 Steel plates and piling</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1 Rails, tires and rolled wheels</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0 Net exports of semi-finished products</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>14 Galvanized sheets</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>13 Tin-free steel</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>12 Tinplate</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>11 Cold-rolled electrical sheets</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10 Cold-rolled sheets</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9 Hot-rolled strips, export high-tensile-strength steel</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8 Steel sheets, medium/thin</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7 Heavy plates, export high-tensile-strength steel</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6 Special steel wire rod</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5 Ordinary wire rod, bar-in-coil</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4 Bars</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3 Sections</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2 Steel plates and piling</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1 Rails, tires and rolled wheels</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0 Net exports of semi-finished products</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</tbody>
</table>

#### Economic categories

- 31. Other specialty steel*
- 30. High-tensile-strength steel*
- 29. Piano wire
- 28. Free cutting steel
- 27. Bearing steel*
- 26. Spring steel
- 25. Structural alloy steel*
- 24. Structural carbon steel*
- 23. High-speed steel*
- +other tool steel
- 22. Alloy tool steel
- 21. Carbon tool steel
- 20. Stainless steel*
- 19. Seamless pipes, specialty steel
- 18. Seamless pipes, stainless
- 17. Other pipes, ordinary steel
- 16. Seamless pipes, ordinary steel
- 15. Other metal coated sheets
- 14*. Galvanized sheets, export high-tensile-strength steel
- 14. Galvanized sheets
- 13. Tin-free steel
- 12. Tinplate
- 11. Cold-rolled electrical sheets
- 10 Cold-rolled sheets
- 9 Hot-rolled strips, export high-tensile-strength steel
- 9 Hot-rolled strips
- 8 Steel sheets, medium/thin
- 7 Heavy plates, export high-tensile-strength steel
- 7 Heavy plates
- 6 Special steel wire rod
- 5 Ordinary wire rod, bar-in-coil
- 4 Bars
- 3 Sections
- 2 Steel plates and piling
- 1 Rails, tires and rolled wheels
- 0. Net exports of semi-finished products

#### Reference – RITE analysis

- Production volume ratio
- Economic category
- Fiscal year
Once steel is produced from iron ore, it can turn into anything time and time again, forever, without losing its functions. Considering this recycling property of steel is extremely important for the assessment of environmental burdens for the entire life cycle of steel.

Conventionally, the calculation was only for production processes. But the environmental value of scrap is also taken into account under these standards. Therefore, it is now possible to quantify the effects of recycling.

The environmental value of scrap is the amount of environmental burdens at the time of production using scrap. To calculate the environmental value of scrap, the amount of environmental burdens necessary for regeneration of scrap is subtracted from the amount of environmental burdens at the time of producing steel from iron ore (A), and then the result is multiplied by the yield ratio at the time of regeneration.

At the time of use of scrap, the environmental value of scrap is added in accordance with the quantity used (B1). At the time of recovery of scrap, the environmental value of scrap is subtracted in accordance with the quantity recovered (B2). The effects of recycling of scrap are calculated by adding B1 and B2.

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**Recycles**

*closed-loop recycling (steel)*

*open-loop recycling (many materials)*

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ISO20915／JIS Q 20915 (Life cycle inventory calculation methodology for steel products)

[Outline of ISO 20915 (which was issued in November 2018) and JIS Q 20915 (which was issued in June 2019)]

- These are standards to calculate environmental burdens for steel products. They are the first standards that include the effects of recycling in the calculation of environmental burdens for material production.
- It is possible to conduct environmental assessment for products using steel by incorporating the effects of recycling through the use of environmental data based on the standards.

- Once steel is produced from iron ore, it can turn into anything time and time again, forever, without losing its functions. Considering this recycling property of steel is extremely important for the assessment of environmental burdens for the entire life cycle of steel.
- Conventionally, the calculation was only for production processes. But the environmental value of scrap is also taken into account under these standards. Therefore, it is now possible to quantify the effects of recycling.
- The environmental value of scrap is the amount of environmental burdens at the time of production using scrap. To calculate the environmental value of scrap, the amount of environmental burdens necessary for regeneration of scrap is subtracted from the amount of environmental burdens at the time of producing steel from iron ore (A), and then the result is multiplied by the yield ratio at the time of regeneration.
- At the time of use of scrap, the environmental value of scrap is added in accordance with the quantity used (B1). At the time of recovery of scrap, the environmental value of scrap is subtracted in accordance with the quantity recovered (B2). The effects of recycling of scrap are calculated by adding B1 and B2.
Developments relating to ISO 20915 and JIS Q 20915

- Standard and rule
  November 2018: The ISO 20915 standard was issued.
  June 2019: The JIS Q 20915 standard was issued.
  June 2019: The EN 15804 standard was revised. (As for building materials covered by the Environmental Product Declaration in Europe, it was made mandatory to include the effects of recycling in assessment.)
  August 2019: The EcoLeaf PCR adopted the ISO 20915 standard and the JIS Q 20915 standard. (All steel products (excluding stainless steel products))
  October 2019: The ISO 20915 standard and the JIS Q 20915 standard were cited in the book Kenchiku koji kanri shishin (Guidelines on supervision of construction work). (Steel-frame work)
  2020: The KS D ISO 20915 standard is scheduled to be issued. (South Korea's domestic standard)

- PR activities in Japan
  - Posters and file folders that say, “Actually, Steel is Light”
    They are put up and distributed in various places.
  - Video titled “Actually, Steel is Light”
    The video was posted on YouTube, and it is run as a commercial in various places. For example, it is shown in Tokyo Metro trains and movie theaters in Tokyo and on large screens at Shibuya’s scramble crossing.
  - Quiz campaigns relating to the concept “Steel is Light”
    The campaigns are held occasionally on Twitter.

Design of the PR poster

- Steel is becoming lighter and lighter.
  • Technology development increases the strength of steel, making steel products lighter and lighter. Steel is a material with a high potential for further advancement.

- Steel can be recycled lightly.
  • Almost all steel products are recovered as scrap after their life cycle, and they are recycled as steel. Steel can turn into anything time and time again (closed-loop recycling).

- Steel has a light burden on the environment.
  • Steel production generates less CO₂ than the production of other materials. Because almost all steel products are recycled, they cause no environmental burdens when they are discarded. Steel places only a light burden on the environment throughout its entire life cycle.